Shocks to bank capital position: Do they matter for lending to firms and how they are channelled?

Evidence from Senior Loan Officer Opinion Survey for Poland

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The author wishes to thank Ryszard Kokoszczyński, Mateusz Pipień, Tomasz Łyziak and an anonymous referee for helpful discussions and comments. The remaining errors are mine. The usual disclaimer applies.
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Abstract

Basing on data from bank lending surveys, we show that shocks to capital position are an important driver of bank lending standards, terms and conditions. Standards for small and medium-sized enterprises are affected more than those for large entities. Shocks to capital are channelled to firms mostly through these terms and conditions which are related to loan price: average spreads and spreads on riskier loans. The third mostly used channel is required collateral. Adverse shocks to capital position result in a lower lending, in particular for real property acquisition and for financing working capital and on current account.

Key words: bank capital, bank lending survey, structural VAR

JEL: E44, E51, G21
1. Introduction

Since the global financial crisis (GFC), capital requirements – a predetermined fraction of loan amount that must be held as equity – became a standard instrument in the macro-prudential policy toolkit, supposed to increase the resilience of the banking sector to adverse shocks and mitigate credit cycles. Basel III and CRD II and III regulation in the EU, imposed on banks a requirement to build buffers of high-quality capital, and resulted in a steady growth of banks’ capital and reserves. Thus, there is a need to have a good grasp of impact of changes in bank capital on lending to the non-financial sector and on the real sector activity.

Banks can increase capital in a few ways: accumulating the retained earnings, issuing new equities, reducing lending and de-risking assets. If banks pursue either of the two latter strategies, it is important to know whether the adjustment is realised through price or the non-price dimensions of credit policy. If the required collateral rises, small and medium-sized enterprises and sole proprietors, i.e. units which are the most vulnerable to information asymmetry, may find it more difficult to have access to bank credit. If, in turn, it is achieved through increased margins, this is an important information for the monetary policy, as it operates through the same channel.

There is a number of papers which explore these topics. Some works provide evidence that an increase in capital is financed from retained earnings, e.g. Cohen (2013), but usually they show that banks transitorily curtail lending and change its structure, e.g. Bridges et al. (2014), Kanngiesser et al. (2017). Bidder et al. (2019) find another possible reaction. Although the study does not investigate banks increasing capital, but those whose borrowers were hit by an adverse shock to the net worth, its conclusions can be relevant for other shocks. Namely, banks tighten corporate lending and mortgages that they would ultimately hold on their balance sheet. In the same time, banks are induced to expand credit for mortgages to be securitized, particularly those that are government-backed. Thus, while the effect of de-risking is unambiguous, this may not be the case for the observed amounts of issued credits.

This paper analyses the impact of shocks to capital on lending standards, terms and conditions as well as on various types of loans to corporates and sole proprietors. It
verifies whether shocks to capital are transmitted through price or non-price channels. Data on bank lending policy and capital position come from Senior Loan Officer Opinion Survey (SLOOS).

Commercial banks which answer the SLOOS questionnaire, account for about 80-90% of total loans to the non-financial sector. Data is weighted by individual bank’s share in the market for a specific type of loan. Thus, it is possible to observe developments in the credit market with respect to various types of loans (long- and short-term) and agents (medium and small-sized corporates, SMEs, the large ones, LEs, and households) with a relatively high precision. The survey shows the net percent of responses, i.e. a difference between a tendency to tighten and weaken credit policy (standards, terms and conditions – henceforth T&Cs). The same applies to factors potentially driving credit policy.

By virtue of the construction of the questionnaire, it brings information on strengthening (weakening) of banks’ balance sheets if it indeed contributed to the variations in credit policy. Put it another way, even if there were some changes in bank capital, but perceived as minor or transitory, and in fact did not affect bank decision on credit policy, they would not be reported in the questionnaire. From the point of view of the goals of this paper, this feature may mean that we dispose less noisy data as compared to the actual capital ratios. However, the survey does not bring information whether the reported changes in the capital position result from exogenous factors, like changes in regulations, or are endogenous.

There exists a plentiful evidence of reliability of bank lending survey data. Used mostly in the monetary transmission literature, they serve to identify credit channel operation. For example, Ciccarelli et al. (2015) and Couaillier (2015) show that monetary policy shocks do affect bank lending policy. Lown and Morgan (2006) find that in the US lending standards have an impact on loans, GDP and inflation. For

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1 „If your bank’s lending policies (credit standards or terms) applied to corporate loans and credit lines have changed over the last three months, please indicate how the following factors have influenced the changes”.

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Narodowy Bank Polski
Poland, Wróbel (2018) shows that monetary policy has a bearing on banks’ lending policy with respect to the corporate sector.

The paper makes use of structural vector autoregression models (SVARs henceforth) and therefore accounts for dynamic relationships between variables and avoids the endogeneity problem. The latter is binding since bank capital depends on macroeconomic developments, monetary policy and lending. We build a set of SVARs and identify shocks to bank capital through a non-recursive decomposition. Models are over-identified. The restrictions are formally tested.

This way of proceeding has a twofold justification. Firstly, it introduces more structure into models as compared to the usual Choleski decomposition. This includes an explicit specification of loan demand and supply functions, capital position and monetary policy rule equations. Moreover, because the restrictions are tested, the models are more reliable. Secondly, the problem of the ordering of the variables is avoided as it sometimes imposes implausible or at least questionable restrictions related to time sequence of reactions of the endogenous variables.

The estimations bring two main observations. First, negative shocks to capital position reduce investment (GFCF) and loans for the real property acquisition. Likewise, loans to sole proprietors fall considerably. Credits on current account and for financing working capital decline somewhat less. Point estimates for investment loans also indicate a negative reaction, but it is not statistically significant. Secondly, after an adverse shock to capital, banks tend to increase average spreads, spreads on riskier loans and the required collateral. This finding conforms Tressel and Zhang (2016) for the euro area. A relatively strong reaction of spreads on riskier loans and collateral as well as the observed behaviour of various types of loans may suggest that shocks to capital induce banks to de-risk their credit portfolio discouraging riskier customers.

The value added of this paper is twofold: it demonstrates that bank lending survey data brings information which helps estimate the influence of macro-prudential policy on the real sector and lending and shows that the main channels of this policy are similar to these of the monetary policy.
The paper is structured as follows: the next section shows stylized facts, the third one reviews the related literature. It is followed by a description of data and methodology. The fifth section describes estimation results, while the sixth one summarizes and concludes.

2 The related figures and tables are shown in the Statistical Appendix.
2. Stylized facts

2.1. Banking sector and lending to corporates

In Poland, banking sector is the most important source of external financing for corporates. Nonetheless, loans to firms related to GDP constitute a modest 13-17%. Corporate bonds issued on the domestic market as well as new issues of shares on the Warsaw Stock Exchange (WSE) play a minor role (Figure A1 in the Statistical Appendix). Small and medium-sized enterprises (SMEs), particularly these belonging to the segment of means of transport, to some extent replace bank loans with leasing. To finance investment, firms rely mostly on their own funds: only 11-13% of investment is financed with bank loans. Banks use flexible credit rates more frequently than fixed rates.

Bank lending to the corporate sector comprises credits in the domestic and foreign currencies (euro is by far the most important foreign currency in bank lending to the corporate sector). Loans in foreign currencies represent some 26-30% of total loans to firms; half of that amount was spent on investment outlays. Some 40% of SMEs and almost 50% of LEs having loans in foreign currencies are exporters, Tymoczko (2013).

Since 2013, to facilitate access to bank lending, SMEs have been eligible for state aid within the *de minimis* Portfolio Guarantee Facility. Under the programme, a state-owned bank grants entities from the SMEs sector, on their request, guarantees to secure the repayment of loans. The programme can be considered as a supplementary collateral and this way it can make credit supply to SMEs more rigid in the case of monetary policy tightening. Currently, about 45% of short-term and 37% of long-term loans are extended to SMEs, GUS (2020).

Figure A2 shows allocation of loans. Manufacturing is the largest recipient of both, short-term and long-term banking loans extended to LEs and SMEs. Electricity, gas and steam supply, information and communication as well as administrative activities are important recipients in the case of long-term loans to LEs, whereas in the case of long-term loans to SMEs the largest beneficiaries are real estate, transportation and storage, administrative activities and construction. Short-term loans, besides
manufacturing go to trade and repair and in the case of LEs to supply of electricity, whereas in the case of SMEs – to construction and administrative activities. However, indebtedness of sections of the economy (F01 GUS data) measured either as the ratio of short-term or long-term loans to firms’ assets shows a somewhat different picture: the most short-indebted are trade and repair, manufacturing and three divisions of services: (i) administrative and support service activities, (ii) education and (iii) health and social assistance. Producers of services, such as accommodation and catering, health and social assistance, culture and recreation are the most long-term indebted, followed by manufacturing and supply of water.

Because riskiness of sections and divisions of the non-financial sector can have some bearing on lending standards, terms and conditions, we have examined data from business surveys on the general climate and financial situation (Statistical Office). We assume that indices of their variation can approximate riskiness. Tables A1 and A2 show descriptive statistics of the “general climate” and “financial situation”. Coefficients of variation of the perceived climate are highly diversified across sectors and sections. The highest are for administrative activities, trade and repair, transport and storage. The respective coefficients for the financial situation vary less; in this case the highest scores are observed for three sections of services: information and communication, accommodation and catering and professional and scientific activities. In all these sectors and sections but information and communication, SMEs play important role. The share of their revenues and investment in the total amount of revenues and investment of the non-financial enterprises ranges from about 60 to 82%. SMEs and sole proprietors are mostly producers of services (about 36% of them, they also operate in trade and repair (about 31%). Another two considerable fractions of SMEs and sole proprietors function in construction (about 14%) and manufacturing (11%), GUS (2015). In turn, LEs operate mostly in industry (almost 52% of them), but they are also active in services (about 31%); about 14% of LEs are present in trade and repair, PARP, (2019).

3 Only the share of SMEs in transport and storage in total investment of this sector is much lower, amounting to some 30%.
Services is the sector of a relatively high income elasticity of demand, displaying higher volatility than others and in the same time populated by SMEs. Because SMEs are riskier borrowers due to information asymmetry, this sector is supposedly more vulnerable to the restrictive credit policy. Trade and repair seems to be vulnerable to credit tightening rather because it is populated by SMEs than because of demand volatility. Thus, some sectors can be more vulnerable because of inherently higher risk, whereas other because they are populated by SMEs. We expect that after a shock to capital, more banks will change their lending policy with respect to SMEs and sole proprietors than LEs.

2.2 Bank capital

Capital ratios are cyclical, as depicted in Figure A3. Cyclical part of capital ratios and capital position from SLOOS\(^4\) as well as those of investment, were obtained from HP-detrending. Trends of the first two variables approximate long-term process of regulatory policy, whereas the last one represents investment potential. Capital ratios were declining in time of booms and increasing with rising risks of busts. “Gaps” of capital ratios lag behind these obtained from SLOOS data by about one quarter, especially in the subperiod ending in 2011.

In general, over the sample, Polish banking system was well capitalized (Figure A4, Figure A5). The average capital ratio remained high, only just before the financial crisis and in 2009 it oscillated around 11%. This was due to regulatory changes which reduced capital requirements against large exposures and general interest rate risk.

In Poland, the post-crisis reform of prudential regulations started even before the official adoption of the macro-prudential framework in 2015. This pre-2015 policy comprised more restrictive policy with respect to capital requirements and risk weights of exposures in currencies other than the obligor’s income. Most of new regulations dealt with loans to households, because a large part of loans for housing was extended in foreign currencies.

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\(^4\) We have detrended accumulated data on capital position from SLOOS.
In 2014 Poland began implementing the CRR/CRD IV package. This caused a further increase in the required levels of regulatory capital, strengthened by a cautious approach of the national supervisory authorities regarding the rules for determining capital ratios. Besides exposures arising from foreign currency housing loans, it was related to payment of dividends. Moreover, the increase in capital ratios was due to a limited scale of implementation of advanced methods of estimating risk exposures. The process of increases of the required capital has become even stronger since 2015. Banks involved in housing loans in foreign currencies extended to unhedged households were subject to surcharges. Those considered as systematically important institutions (OSII) had to hold adequate capital buffers. Also, a newly imposed conservation buffer was gradually phased in. It amounted to 1.25% of the total risk exposure in 2016 and to 2.25% in 2019. Since the beginning of 2018, a systemic risk buffer at the rate of 3% has been introduced to prevent and mitigate long-term non-cyclical systemic risk.

The usual practice of the regulator in Poland is to pre-announce changes in the macro-prudential instruments well before their formal implementation. This makes it easier and smoother for banks to adjust. As a result, changes in capital requirements resulting from the macroprudential policy can hardly be considered as unexpected. However, in the paper, we may in fact capture the effects of announcements of changes imposed by regulators, since it uses survey data.

Capital ratios are closely related to holdings of treasury bonds in banks’ portfolios and to loans extended to the corporate sector, Figure A4. To check this relationship more formally, we have built a bivariate error correction model (both variables are integrated of order one). An exogenous dummy captures the impact of a tax on banks’ assets, introduced in 2016. Johansen test shows the existence of a cointegrating relationship between banks’ holdings of treasury bonds expressed as per cent of nominal GDP and the capital ratio\(^5\). In the long-run, an increase in the capital ratio by 1 pp. leads to an increase in such a measure of T-bonds held by banks by about 0.7 pp. The coefficient of error correction equal to -0.4 means that 40% of disequilibrium

\(^5\) Before 2014 – capital adequacy ratio (CAR) and total capital ratio (TCR) thereafter.
tends to be eliminated within one quarter. Importantly, capital ratio passes weak exogeneity test (Chi-square(1) =1.26, p.0.26). The dummy representing tax on assets is positive and significant in the dynamic equation.

Johansen test shows that there is also a long-term relationship between capital ratios and loans to the corporate sector related to GDP, but the estimate of the long-run multiplier of the capital ratio, equal to 0.09, is much lower comparing to this obtained in the model for the T-bonds. The speed of adjustment to equilibrium is however similar (-0.37). In this case, capital ratio does not pass weak exogeneity test (Chi-square(1) =18.38, p.0.00). This is because increasing lending requires more capital, which is not necessarily offset by changes in the lending structure.

There exists a clear-cut relationship between capital ratio and data on capital position reported in the survey. Figure A5 presents capital ratio (TCR) and accumulated data from SLOOS. Johansen test points out that TCR and accumulated data from SLOOS are cointegrated. However, the estimated coefficient at the error correction term is low (-0.04). Changes in capital position from SLOOS are weakly exogenous with respect to changes in the capital ratio. What is more, Granger causality test shows that data from the survey “cause” changes in the capital ratio. We do not interpret such Granger causality test as a pure causality between the two variables. We argue that data from SLOOS are forward-looking. Credit officers deduce both macro-prudential requirements and the necessary adjustments in capital resulting from current and expected variations of the structure of their banks’ asset portfolio and the related risks. Thus, data from the survey bring additional information on developments in capital ratios.

To verify if the relationship standing behind Granger causality is stable, we applied CUSUM and CUSUM of Squares Tests. They are suggestive of a general stability of parameters. Chow break-point test applied to check whether there was a break in 2014 when macro-prudential policy started, rejects the structural break.

Data on capital position from SLOOS display 4 episodes when banks considerably increased their concerns, Figure A6. The first one is related to the GFC. It started in the late 2007, with the first disturbances in the world financial markets and culminated
in the beginning of 2009. Then, credit officers signalled possible difficulties during the European sovereign debt crisis. Another two episodes of a significant worsening of capital position were reported in 2016 and 2019; the former was possibly related to the expected falling profits due to the introduction of a new tax on banks’ assets. This is important, because in Poland, retained profits are the most important source of an increase in banks’ capital: in years 2000-2015 it was by 56.5% on average, NBP (2016). The latter incident of the worsening of capital position had presumably similar reasons.

2.3. Lending standards, terms and conditions

Lending standards are understood as bank’s internal guidelines related to approving loan applications (e.g. minimal expected rate of return on a business project). Lending terms and conditions comprise spreads on average loans, spreads on riskier loans, non-interest rate costs of loans, collateral requirements, maximum size and maturity.

Developments of lending standards, terms and conditions (T&Cs) are similar to those reported on capital position. Standards on loans to SMEs have somewhat higher variability than standards for LEs. It seems that in “good” times, banks tended to gain more ground in the SMEs’ segment of the market, but in the “bad” ones, this riskier segment was more vulnerable to tightening of credit policy.

Likewise, variability of average spread is higher than of other T&Cs, especially this of maximum size and maturity, Figure A7, Figure A8. Spreads seem to be less downward rigid than other T&Cs. To explain this phenomenon, we have examined correlation of risk factors reported in the survey with lending terms and conditions and variables from the real sector, such as changes in GDP and investment. Whereas correlation between the last two variables and spread did not differ much comparing to other lending terms and conditions, spreads turned out to reflect developments in capital position and macroeconomic risk more than any other lending term. In

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6 A tax on certain financial institutions, including banks, imposed in the early 2016, requires them to reimburse every month the equivalent of 0.0366% of their assets to the state budget. However, the holdings of treasury bonds are exempt from the taxation base. As a result, banks significantly increased their portfolios of government bonds in 2016Q1. Despite the tax, loans to the corporate sector increased as well, but at much slower rate.
particular, two episodes of a considerable spreads fall (in 2011 and 2012) reflected developments of capital position declared by credit officers. This suggests that banks adjusted average spreads to changes in their lending capacities related to capital and to the expected evolution in the NPV of projects resulting from developments in the business cycle. Other lending terms and conditions, e.g. maturity or collateral, seem to be more related to the quality of banks’ assets (the share of non-performing loans).

To verify how “soft” information on selected T&Cs from the survey corresponds to “hard” statistical data, we compare data on average spread and spread on riskier loans from SLOOS with margins over 3-month money market rate (WIBOR), calculated using respectively: (i) interest rate on total new loans to the corporate sector, and (ii) the rate on new loans to sole proprietors. We take first differences of the statistical data, since credit officers report on changes in T&Cs with respect to the previous quarter. Sole proprietors are “more risky borrowers” although we are conscious that the corporate sector also includes some riskier segments, e.g. construction or services of high demand elasticity.

Figure A9 and A10 and Table A3 show the reported and calculated spreads and their correlation coefficients in time $t$, $t-1$ and $t+1$. Correlation between spreads on loans to sole proprietors and data from SLOOS is higher than this on loans for the corporate sector. Nonetheless, also in the latter case, the correlation coefficient is significant. Spreads from monetary statistics, for both corporates and sole proprietors are more strongly correlated with data from SLOOS on spreads on riskier than on average loans. This is surprising since we expected that spreads for corporates would be more closely related to these on average loans. The highest correlation coefficients are obtained for time $t$, however, there is also a strong correlation of spreads for the corporates and sole proprietors in $t+1$ with SLOOS data in time $t$. Granger causality tests confirms that SLOOS data “Granger cause” these from the monetary statistics.
3. Related literature

There exists a vast theoretical and empirical literature on the impact of bank capital on the real sector and lending. Since the implementation of the macro-prudential policy in the aftermath of the GFC, the discussion has become even more vivid, as many of these instruments are capital-based. The issues concern its bearing on the real and financial sectors, effectiveness in curtailing loans, channels through which it operates and interactions with the monetary policy.

Naturally, the discussion refers to the Modigliani-Miller theorem according to which capital requirements have little influence on bank lending and investment. If, for some reason, the requirements increase, banks willing to maintain lending can issue new equity at a modest cost. The opposite view argues that if equity is scarce and its rising is difficult and costly, banks may have to abandon some projects with a positive net present value, since they consume too much of the regulatory capital. Thus, banks reduce lending to the non-financial sector which results in a lower investment activity.

There are three strategies which banks may follow to adjust their capital: (i) issue new equity, (ii) use the retained earnings, (iii) deleverage – this may mean reducing lending and risk weights, i.e. changing the structure of lending or the structure of total assets increasing the share of these which are safer, such as government securities.

The empirical evidence on the strategies adopted by banks in the aftermath of the GFC crisis is mixed. Analysing a sample of 82 large global banks from advanced and emerging economies, Cohen (2013) finds that retained earnings accounted for the bulk of the increase in risk-weighted capital ratios over the period 2009–12, with reductions in risk weights playing a lesser role. On average, banks continued to expand their lending, though at a slower rate. Lower dividend pay-outs and wider lending spreads contributed to banks’ ability to use retained earnings to build capital. Kanngiesser et al. (2017) show that in the euro area banks rather tend to de-risk their portfolios, away from loans which are more capital intensive and adjust lending (and hence RWAs) to a larger extent than they increase the level of capital and reserves per se. A short review of the recent results on the impact of capital on lending and output is provided in Fender and Lewrick (2016).
Literature showing evidence on the specific channels of macroprudential policy transmission, including behaviour of lending terms and conditions is scarcer. In general, works which analyse behaviour of T&Cs show how they depend on the riskiness of borrowers or how they are affected by monetary policy. In this first strand, Strahan (1999) demonstrates that tighter non-price terms are applied in contracts of riskier firms. Loans to small firms, firms with low ratings, and firms with little cash available to service debt, are more likely to be small, to be secured by collateral, and to have a short contractual maturity. In the analysis of maturity of credit lines for small business Ortiz-Molina and Penas (2008) find that maturity and collateral are substitute mechanisms in mitigating agency problems, and that maturity increases with collateral pledges. Collateral types that better mitigate agency problems reduce the sensitivity of loan maturity to informational asymmetries and risk. In the second strand, Black and Rosen (2016) show that monetary policy tightening reduces the supply of commercial loans by shortening loan maturity.

Tressel and Zhang (2016) analyse how macroprudential policy is channelled and find that it is transmitted mainly through price margins. Our paper, although focusing on lending to firms, and using another estimation strategy, confirms this finding.

Due to a short history of macro-prudential policy and its specific instruments, such as countercyclical capital buffers, econometric analyses are difficult. Empirical papers may analyse bearing of shocks to bank capital and extend the results on the effects of capital-based macro-prudential instruments. Other resort to loan-level data and investigate episodes of changing capital requirements, like a transition to Basel II, i.e. from a homogenous requirement of 8% imposed on all loans, to a system of capital requirements which differ both across borrowers of the same bank, and across banks within a given firm, Fraisse, Lê, Thesmar (2017).

There are two other problems which make estimates non-trivial. Firstly, it is endogeneity, since bank capital reacts to the monetary policy, lending and demand conditions. Secondly, it is disentangling demand and supply of loans.

As discussed in Kangiesser et al. (2017), there exist broadly three ways of solving the endogeneity problem: the first one is to isolate shocks to bank capital per se by
estimating the response of banks to losses associated with real estate exposures or a stock market collapse, the second one – to isolate regulatory shocks, e.g. resulting from a stricter supervision. Finally, the third one is identification of shocks to bank capital through a structural time series modelling, such as vector autoregression model. The argument for using VAR model is that it captures dynamic interactions between banking and macroeconomic variables, while imposing a modest set of restrictions.

This paper is related to the latter strand of the literature. We use a set of classical SVARs. In contrast to the earlier studies which employed Choleski decomposition, e.g. Lown and Morgan (2006), we identify structural shocks using a non-recursive decomposition. This way we avoid the problem of dubious assumptions related to the time sequence of macroeconomic developments, inherent to Choleski decomposition, and can test the over-identifying restrictions.

Recently, there has been a growing literature where structural shocks are identified with sign restrictions or a combination of zero and sign restrictions imposed on the impulse responses, e.g. Noss, Toffano (2016), Gambetti, Musso (2017), Kangiesser et al. (2017), Meeks (2017), Kumamoto, Zhuo (2017). However, this procedure only provides set identification (it does not identify a single SVAR, but a set, and thus a set of shock-candidates. Moreover, the identified shocks can be a linear combination of other shocks, Wolf (2019). Machine learning vector autoregressions make only first steps in casual inference, Varner (2017).

The problem of disentangling demand and supply of credit can be alleviated by using lending survey data, where banks explicitly report on them. This is what is done in this paper. Bank lending surveys were primarily used in the monetary transmission literature to check the existence of credit channels, e.g. Lown and Morgan (2006), De Bondt et al. (2010), Maddaloni and Peydró (2013). Recently, they have also been used in analyses of the effects of macro-prudential policy, e.g. Berrospide and Edge (2010) who consider the effect of capital ratios on lending applying a variant of Lown and Morgan’s (2006) VAR model, and – in contrast to other studies – find that these effects are modest. The Euro area BLS is also used in Tressel and Zhang (2016).
4. Data and estimation method

4.1. The Survey

In Poland, the Survey\(^7\) was launched in 2003. It is conducted by the central bank on a quarterly basis. Loan officers answer a set of questions related to loan supply and demand to the non-financial corporations and households. They declare whether credit standards, terms and conditions have been (i) tightened considerably, (ii) tightened somewhat, (iii) remained basically the same, (iv) eased somewhat, (v) eased considerably. Standards are minimum standards of creditworthiness, set by banks, that the borrower is required to meet to obtain a loan. Banks report also on lending terms and conditions. This category comprises three price dimensions: average spread \((\text{spread})\), spread on riskier loans \((\text{spread\_risk})\), and non-interest rate cost \((\text{ni\_cost})\), and the same number of non-price elements, namely the required collateral \((\text{collateral})\), maximum size \((\text{size})\) and maximum maturity \((\text{maturity})\) of a loan. Throughout the paper, a positive value of shocks to capital position means an adverse innovation, i.e. a perceived deterioration of the capital position\(^8\).

Loan officers are requested to rate factors which potentially drive lending standards. They comprise (i) risks related to the borrowers – macroeconomic risk, industry-specific and related to the default of the largest borrowers of a bank, (ii) risk related to the lenders – capital position and the share of non-performing loans in total loans), and (iii) structural factors (competition from other banks and non-bank financial institutions, as well as from market financing (debt/equity issues).

The possible array of answers ranks from (i) have contributed to tightening considerably, (ii) have contributed to tightening somewhat, (iii) have basically not contributed to any changes, (iv) have contributed somewhat to softening to (v) have considerably contributed to softening.

27 banks, which currently respond to the survey, possess about 90 per cent of total loans to the non-financial sector (extended in the domestic currency and in foreign


\(^8\) We have multiplied original survey data on capital, standards and lending terms and conditions by (-1) to make their influence on macroeconomic variables analogous to the interest rate.
currencies to both corporates and households). The number of banks involved was changing over the period covered by the survey, mostly due to mergers and acquisitions.

The aggregation of data consists in the calculation of weighted percentages of responses and the net percentage, i.e. the difference between the structures presenting opposite trends, i.e. have contributed slightly and have contributed considerably to tightening vs. have contributed slightly and have contributed considerably to softening. The importance of banks in a given market segment is represented by the share of loans outstanding of this bank in the loan portfolio of all banks that respond to the survey, broken down by types of loans. Thus, a weight, corresponding to a given bank’s share in a given market segment is assigned to particular responses.

The survey contains lending standards applied to large and small and medium sized enterprises, on short-term loans or long-term loans, referred to as $std_{i,j}^t$, where $i=1$ if the standards refer to LEs or $i=2$ if they refer to SMEs; $j$ denotes loan maturity: $j=1$ for long-term loans, and $j=2$ for short-term loans.

4.2. Non-survey data

Besides data from SLOOS, which have been already presented in the section on the stylized facts, we use data on investment, three types of loans to the corporates in the domestic currency: (i) for investment, (ii) for real property acquisition (RPA henceforth) and (iii) for financing current account and working capital (WC&CA). We also examine loans to sole proprietors, who formally belong to the household sector. WC&CA loans are treated as short-term and therefore used solely in models with standards on short-term credits. In turn, credits for investment and RPA correspond to standards on long-term loans\textsuperscript{9}. Loans to sole proprietors are mostly short-term. All loans are in real terms. They are calculated using investment price

\textsuperscript{9} We do not analyze credits dubbed as ‘other’ since it would be impossible to ascribe them the proper maturity.
deflator or GDP price deflator (2015=100) in the case of loans to sole proprietors. These data are in log-levels to avoid the loss of information caused by differencing.

3-month money market interest rate, WIBOR, approximates monetary policy rate. In the long-run it fully adjusts to the NBP reference rate10 and is frequently used by banks as a benchmark to set retail lending rates, Chmielewski et al. (2020). In the robustness checks, we also use POLONIA rate, i.e. the overnight reference rate, and two lending rates: average rate on new credits to the corporates and on credit on current account.

Since Poland is a small open economy, we plug in two exogenous euro area variables, namely 3-month Euribor and investment in the euro area (12 countries) to pin down close trade and financial interrelationships. Details on sources and the construction of variables are presented in the Statistical Appendix (Table A4). The estimations cover the sample 2003Q4-2019Q2.

4.3. Estimation method

We use a suite of vector autoregression models (SVARs) and non-recursive decompositions to show responses of investment and various types of loans to shocks to changes in capital position reported by credit officers.

In the baseline setting, we have five endogenous variables: investment of the corporate sector, credit volume11, capital position from SLOOS, the interest rate and credit standards (or alternatively one of T&Cs). Such a set of variables makes it possible to control for business cycle developments and monetary policy.

We build three groups of models. The first one contains investment loans, RPA loans and long-term standards for either large or small and medium-sized enterprises. The second one - short-term loans (WC&CA) and short-term standards, as before for LEs

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10 The point estimate of the long-run adjustment coefficient is equal to 0.96, but the formal test does not reject $H_0$ of full adjustment.

11 Although banks’ credit policy concerns both loans in the domestic and in the foreign currencies, we leave aside the latter category. It blurs reactions of loans to the domestic interest rate since it depends rather on a spread between domestic and foreign interest rate and because to make the model well-specified, we would have had to introduce the exchange rate. Bearing on mind data shortness, we cannot expand our model by two variables more.
and SMEs. The last group is devoted solely to sole proprietors. In total, we have 32 models with various combinations of loans and lending standards or terms and conditions. The necessary model parsimony has, however, two major drawbacks. Firstly, it excludes a possibility to directly analyse interrelationships between various types of loans. We can do it only indirectly, comparing responses from various models. Secondly, since there is no lending rate in the models, the identification of shocks to demand for loans can be problematic. We refer to this problem in the robustness checks tentatively introducing the lending rate into selected models.

If the underlying structural model is as in (1)

\[ AY_t = C(L)Y_{t-1} + Bv_t, \]

where \( Y_t \) is a vector of endogenous variables, \( A \) is a vector of contemporaneous relations among the variables, \( C(L) \) is a matrix of a finite order lag polynomial, and \( v_t \) is a vector of structural disturbances, we can estimate a VAR model as the reduced form of the underlying model:

\[ Y_t = A^{-1}C(L)Y_{t-1} + u_t, \]

where \( u_t \) is a vector of VAR residuals, normally independently distributed with full variance-covariance matrix \( \Sigma \). The relation between the residuals and structural innovations is:

\[ Au_t = Bv_t \text{ and} \]

\[ B^{-1}Au_t = v_t \]

To identify the structural shocks, it is necessary to impose restrictions on matrices \( A \) and \( B \) in (4).

Although at first glance we might use Cholesky decomposition (he survey is released with a one quarter lag), we employ a non-recursive factorization which allows a simultaneous reaction of lending standards (or terms and conditions) and the short-term interest rate. Namely, we argue that in fact central banks may have contemporaneous information at least on some elements of banks’ credit policies, as
they are provided on banks’ web sites. It is therefore conceivable that such information is contemporaneously scrutinized, because since the GFC there has been a growing understanding of potentially disastrous effects of disturbances in credit on the real sector. That assumption seems plausible also for inflation targeting countries.\(^\text{12}\)

We assume that owing to real and nominal rigidities investment \((\text{inv}_t)\) reacts to developments in monetary policy \((i_t)\) and credit standards, terms and conditions with a lag. Demand for loans \((l_t)\) depends on the scale variable, i.e. investment, and the interest rate. Capital position \((\text{capital}_t)\), which is supposed to cause changes in credit standards, terms and conditions depends contemporaneously on the current state of the economy and the related risks. They are approximated by investment activity of the corporate sector. Moreover, capital position depends contemporaneously on developments in loans, as each credit requires additional capital. Because Narodowy Bank Polski conducts inflation targeting policy, the policy rule should respond to developments in prices and the real sector. However, to preserve model parsimony, we do not explicitly include prices. Thus, in the model, monetary policy rate responds contemporaneously to developments in investment. As mentioned above, there is a contemporaneous feedback between the interest rate and credit standards or alternatively interest rate and credit terms and conditions. Besides, banks’ lending policy is contemporaneously impacted by investment and perceived capital position.

The set of restrictions in matrices A and B is as in (5). To simplify the notation below, we refer to all types of loans analysed in the paper as \(l_t\) and to all lending standards, terms and conditions, which approximate loan supply as \(\text{supply}_t\).

\[
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 \\
\alpha_{21} & 1 & 0 & \alpha_{24} & 0 \\
\alpha_{31} & \alpha_{32} & 1 & 0 & 0 \\
\alpha_{41} & 0 & 0 & 1 & \alpha_{45} \\
\alpha_{51} & 0 & \alpha_{53} & \alpha_{54} & 1 \\
\end{bmatrix}
= 
\begin{bmatrix}
\text{ui}^\text{inv}_t \\
\text{ui}_t \\
\text{ui}^\text{capital}_t \\
\text{ui}^\text{supply}_t \\
\end{bmatrix}
= 
\begin{bmatrix}
\text{vi}^\text{inv}_t \\
\text{vi}_t \\
\text{vi}^\text{capital}_t \\
\text{vi}^\text{supply}_t \\
\end{bmatrix}.
\]

The model is overidentified by one restriction. The restrictions are formally tested. We obtain 5 shocks: to investment (aggregate demand shock), to credit demand, to

\(^{12}\) There is some evidence that inflation targeting countries, both developed and emerging markets, are responsive to credit conditions, Choi, Cook (2018).
capital position, to the monetary policy rate and to credit supply (a shock to standards or terms and conditions).

Positive aggregate demand shocks are supposed to increase firms’ demand for loans; in the short-run they may also lead to a less stringent banks’ lending policy, owing to a lower risk perception.

The impact of shocks to loan demand on the model variables is more complicated and ambiguous. These shocks need to be independent from developments in the real sector and the interest rate. They may result from a change in borrowers’ preferences with respect to the external financing, e.g. from a change in the role of retained earnings in financing investment or using other sources of external financing. Besides, shocks to demand for investment loans may reflect innovations to technology which induces firms to invest in a novelty. Shocks to demand for loans for real property acquisition may reflect a speculative bubble.

Shocks to demand for credit on current account may have somewhat different properties. Firstly, in the case of existing credit lines, the interest rate, terms and conditions remain largely fixed following adverse shocks. Thus, shocks to demand for loans on current account may in principle affect the rate on new credit lines but not on the existing ones. Secondly, to some extent, such shocks can be grasped by draw-downs of the existing credit lines. Thus, if a firm has an unused limit and is affected by an unexpected shock, such as a sudden drop in cash flows, observed during COVID-19 outbreak, it can simply resort to the existing credit facility. A similar effect may induce an arrival of short-lived opportunities to capture investment projects, Martin and Santomero (1997). Berrospide and Meisenzahl (2015) find evidence that during the financial crisis 2007-2009 in the US, firms used draw-downs to sustain investment after an idiosyncratic liquidity shock.

Since loans on current account are less likely to undermine financial stability of a given economy, in the case of an unexpected shock, monetary policy can be simply accommodative. To some extent, in response to positive shocks to demand for credits for investment, monetary policy may also tend to be accommodative, supposing that investment will add to the potential. As a result, also the reactions of lending rates to
such credit demand shocks are supposed to be relatively small. In contrast, central bank reactions to shocks to demand for loans for real property acquisition, which may lead to a bubble, are expected to be large and significant.

Lending rates may increase independently from the policy rate as a result of a higher demand for loans. The size of the effect may depend on structural features of credit market like competition or relationship lending. The former is supposed to curb the response, whereas the latter may reduce the upward responsiveness and amplify that which is downward.

Similar arguments can be applied to shocks to demand for loans to sole proprietors. However, this group of customers is more risky, thus banks can be more eager to increase interest rates after a positive credit demand shock.

Thus, since we analyse separately loans for investment, RPA, WC&CA and to sole proprietors, in fact we identify four shocks to loan demand which probably do not have uniform properties and impact on the model variables.

Monetary policy tightening is expected to make lending policy of banks more stringent, curb lending and investment. However, empirical findings frequently display credit puzzles after monetary tightening. One explanation is that an increase in interest rates induces banks to re-balance their loans portfolio in favour of more profitable and less risky short-term corporate loans, reducing the stock of loans to households. Another explanation for this finding is that facing the upward pressure on their cost of lending induced by monetary tightening, firms may be encouraged to draw-down their pre-committed credit lines with banks. Lastly, demand for loans may increase in an economic recession due to the need of firms to address the squeeze in their cash flows, Giannone et al. (2019).

Finally, adverse shocks to banks’ lending policy are supposed to reduce lending to corporates and have some bearing on investment, however, due to a relatively small share of investment financed with bank loans, this fall can be minor.

Despite some ambiguity concerning the impact of loan demand shocks on other model variables, impulse responses to all five shocks serve us as a robustness check of our
models. To have a further check of credit demand shocks identification, we re-specify a few models (these containing lending standards), introducing a second interest rate. This can ameliorate the estimates for two reasons. Firstly, because this allows for the contemporaneous impact of developments in credits on the policy rate, as suggested by the empirical findings for inflation targeting countries in Choi and Cook (2018). Secondly, in the six-variable setting, demand for various types of credit is a function of a specific lending rate: average rate on new loans for the corporates in the case of investment and real property loans and on current account for credit lines and loans for financing working capital. The enlarged model is used only to verify the impact of credit demand shocks, since their identification looks a priori the most problematic.

The set of restrictions used in the enlarged model is as in (6):

\[
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 \\
\alpha_{21} & 1 & 0 & 0 & \alpha_{25} & 0 \\
\alpha_{31} & \alpha_{32} & 1 & 0 & 0 & 0 \\
\alpha_{41} & \alpha_{42} & 0 & 1 & 0 & \alpha_{46} \\
0 & 0 & 0 & \alpha_{54} & 1 & 0 \\
\alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & 0 & 1
\end{bmatrix}
\begin{bmatrix}
u_{t}^{inv} \\
\nu_{t}^{l} \\
\nu_{t}^{capital} \\
\nu_{t}^{i_lend} \\
\nu_{t}^{lend} \\
\nu_{t}^{supply}
\end{bmatrix}
= 
\begin{bmatrix}
u_{t}^{inv} \\
\nu_{t}^{l} \\
\nu_{t}^{capital} \\
\nu_{t}^{i_lend} \\
\nu_{t}^{lend} \\
\nu_{t}^{supply}
\end{bmatrix}
\]

Where \( i_{lend} \) denotes either of the two lending rates. The model is overidentified by 3 restrictions.

Besides, in a series of other robustness checks, we have re-estimated the standard models replacing WIBOR 3M rate with POLONIA rate, i.e. the rate which reflects fluctuations of overnight prices of deposits in the interbank market and which is officially targeted by the central bank. POLONIA gradually gains more and more ground as a benchmark rate. Because it was introduced only in 2005, the missing data for the period 2003Q4-2004Q4 were filled with WIBOR O/N rate.
5. Results

The benchmark models are over-identified by one restriction. For all models, Chi-square tests show that restrictions cannot be rejected, validating the adopted set of assumptions. Figure 1 and Table 1 in the main body text bring the results. Responses of investment and loans to shocks to capital are hump-shaped; investment returns to the baseline somewhat faster than loans.

5.1. Impulse responses of standards, T&Cs to shocks to banks’ capital position

The reactions of lending standards and T&Cs are presented in Table 1. This makes comparisons easier, since we estimate a considerable number of models. Shocks are normalized across models to 15% (they usually ranged from 14.6% to 16%). The responses and error bands are respectively recalculated. We show the responses on impact and indicate, when it applies, which of them are statistically insignificant.

Shocks to capital position (worsening) lead banks to tighten credit policy. Responses of standards for LEs and SMEs, as well as of T&Cs are all statistically significant with exception of maximum size and maturity in models with WC&CA credits. The latter results from the properties of these loans.

As expected, after an innovation, more banks tends to tighten standards for SMEs than for LEs. This is particularly true in the case of standards on long-term loans. While a typical reaction of standards for SMEs is 7.5-9.9%, this for LEs is around 4.9-6.4%, depending on the model. This means that in response to shocks to capital, banks tend to de-risk their credit portfolios.

After a shock to capital, more banks would tighten standards for LEs on WC&CA loans are than those on long-term loans (however, we do not observe a similar pattern in reactions with respect to shocks to the monetary policy). Such behaviour is somewhat surprising, since in general, short-term loans carry less risk than the long-term ones. Moreover, short-term credits are repaid out of a conversion of assets, unlike long-term loans which require free cash flow from operations. Also, the size of short-term loans is usually smaller. Long-term loans mean a more extensive relationship, which reduces monitoring costs and risks. This might explain such a counterintuitive
phenomenon, providing that the impact of the interest rate shock would have a similar property – but this is not the case. A possible explanation is that banks may want to reduce the scope of a possible substitution of long-term loans by these on current account. Borrowers that fear that obtaining investment loan may be more difficult, will use draw-downs of the existing credit lines, whereas lenders would probably like to curb demand for the new ones.

An alternative hypothesis is that riskier LEs tend to take rather short-term than long-term loans. As demonstrated before, besides manufacturing and electricity and steam supply, short-term loans extended to LEs, are allocated in trade and services, which were indicated as more volatile in terms of economic climate and/or perceived financial situation. Thus, although we do not have more convincing proofs, none of these hypotheses can be rejected.

Responses of T&Cs show that after a shock to capital, banks mostly adjust average spread and spread on riskier loans, i.e. rather price than non-price conditions. Although these two kinds of T&Cs are used the most, there is a considerable difference between them: the response of spreads amounts from about 10 to nearly 12%, depending on the model, this of spreads on riskier loans from about 5 to 6%. It should be noted here, that it does not mean that average spreads increase more than spreads on riskier loans, but that after an innovation to capital, more banks (asset-weighted) tend to tighten average spreads than spread on riskier loans. The third largest response is that of required collateral, followed by another price dimension of credit policy, i.e. non-interest rate cost. Thus, it seems that banks react mostly reducing the overall supply of credits, and as a second most frequently used strategy – de-risk their loan portfolio. These results are in line with Tressel and Zhang (2016) for the euro area.

Responses obtained from models which employ loans to sole proprietors display a pattern suggesting that these borrowers are perceived as risky customers and seem to be the most vulnerable to tightening of loan supply. The response of spread is the highest of all obtained from our models, whereas this of spread on riskier loans is close to that from model with RPA loans by the corporates. Responses of other T&Cs
are more in line with those obtained for the corporate sector. This shows once again that banks are willing to de-risk their portfolios.

Table 1. Responses of standards, T&Cs (in %) to a standardized 15% adverse shock to capital position.

<table>
<thead>
<tr>
<th>$std_{i,j}^t$</th>
<th>Models with investment loans</th>
<th>Models with RPA loans</th>
<th>Models with WC&amp;CA loans</th>
<th>Models with loans to sole proprietors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i=1, j=1$</td>
<td>4.9</td>
<td>6.4</td>
<td>non-applicable</td>
<td>non-applicable</td>
</tr>
<tr>
<td>$i=2, j=1$</td>
<td>7.5</td>
<td>9.9</td>
<td>non-applicable</td>
<td>8.6</td>
</tr>
<tr>
<td>$i=1, j=2$</td>
<td>non-applicable</td>
<td>non-applicable</td>
<td>7.1</td>
<td>non-applicable</td>
</tr>
<tr>
<td>$i=2, j=2$</td>
<td>non-applicable</td>
<td>non-applicable</td>
<td>8.0</td>
<td>8.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T&amp;Cs</th>
<th>spread$_i$</th>
<th>spread$_{risk_i}$</th>
<th>ni$_{cost_i}$</th>
<th>collateral$_i$</th>
<th>size$_i$</th>
<th>maturity$_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10.4</td>
<td>11.8</td>
<td>10.8</td>
<td>12.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.3</td>
<td>5.9</td>
<td>5.1</td>
<td>5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2</td>
<td>3.7</td>
<td>2.6</td>
<td>3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.9</td>
<td>5.1</td>
<td>3.8</td>
<td>4.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.8</td>
<td>3.8</td>
<td>insignificant</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td>2.3</td>
<td>insignificant</td>
<td>insignificant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Own calculations. Note: $i=1$ stands for LEs, $i=2$ for SMEs, $j=1$ stands for long-term loans, $j=2$ for short-term loans.

5.2. Impulse responses of investment and loans to shocks to banks’ capital position

Besides inducing tighter credit policy of banks in terms of both, standards and T&Cs, (adverse) shocks to capital position gradually increase the interest rate, which reaches its maximum reaction of 0.2 pp. 4 quarters after the innovation (in models which were used in robustness checks, the increase in POLONIA is smaller and amounts to 0.1 pp.). As a result, investment falls, followed by a reduction in loans for real property acquisition and short-term loans for financing working capital and on current account. Responses of investment loans, although negative, are statistically insignificant (we use 95% confidence intervals).

In particular, impulse response functions depicting reaction of investment, obtained from models which contained investment loans as a variable representing loans to the non-financial firms, show a statistically significant effect starting from the 2nd quarter after the shock. The maximum effect lies between 1 and 2% and shows up with a
relatively long delay of some 8-11 quarters, Figure 1 (panel A depicts IRFs from 8 models which differ by standards and T&Cs). Models using other types of loans produce similar results, thus for the sake of space limits, they are not presented here.

In the case of loans for real property acquisition, all models but one, namely this using maximum size of loan as a variable representing lending T&Cs, give impulse response functions which are statistically significant, either immediately after the innovation (model with maximum maturity) or after 7-8 quarters, Figure 1, panel B.

Investment loans are less affected than RPA loans. Their fall is slower and smaller. The point estimate of this reaction is comparable to that of short-term loans, but the estimate is more uncertain. Reactions of short-term loans are also statistically significant after 7-8 quarters and later on, matching a maximum reaction of investment. Two models out of a total number of eight using this category of loans, produce a temporary puzzle, i.e. loans increase despite a worsening of banks’ capital position. The puzzle is not statistically significant, but it may mean that in fact there exists some substitution of the long-term loans by these on current account, Figure 1 panel C&D.

Loans to sole proprietors, considered here as a separate category, tend to fall after a shock to bank capital position. As in the case of other loans, this reaction is significant after 7-8 quarters (Figure 1, panel E). It is relatively quick and large, comparable to this of loans for real property acquisition for corporates. Thus, it seems that despite de minimis programme, which can be considered as an additional collateral provided to the smallest firms, they are the most vulnerable.

Responses of investment as well as of loans to shocks to capital display some persistence. They return to the baseline after 36-40 quarters. These long-lasting responses seem to be caused by persistence in reactions of the interest rate and standards and T&Cs.

Decomposition of variance of loans to corporates and sole proprietors, Table 2, provides information from a slightly different perspective: it confirms that shocks to
capital are the most important for loans for real property acquisition and to sole proprietors and that their role increases with time, in contrast to the short-term loans.

Figure 1. Impulse response functions of investment and various types of loans to shocks to capital position from models with various lending standards, T&Cs

A. IRFs of investment (solid lines) from models with investment loans.

B. IRFs of loans for real property acquisition (solid lines).

C. IRFs of investment loans (solid lines).
D. IRFs of loans for working capital and on current account (solid lines).

E. IRF of loans to sole proprietors to shocks to capital (solid lines)

Horizontal axis shows quarters after the shock, vertical axis shows a change in the respective loans in %.
“Collateral”, “maturity” mean a model with collateral or maturity as a variable representing T&Cs. SMEs or LEs mean the respective lending standards. Dashed lines are for the respective confidence intervals ± 2 S.E.
Source: Own calculations.

Table 2. Variance decomposition of loans: the role of capital shocks, in %

<table>
<thead>
<tr>
<th>Quarter after the shock</th>
<th>Investment loans</th>
<th>Loans for real property acquisition</th>
<th>Loans in current account and for working capital</th>
<th>Loan to sole proprietors</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.6</td>
<td>1.5</td>
<td>3.1</td>
<td>0.3</td>
</tr>
<tr>
<td>8</td>
<td>2.2</td>
<td>6.6</td>
<td>3.7</td>
<td>2.5</td>
</tr>
<tr>
<td>12</td>
<td>3.9</td>
<td>17.9</td>
<td>3.1</td>
<td>9.1</td>
</tr>
<tr>
<td>16</td>
<td>5.4</td>
<td>26.0</td>
<td>2.9</td>
<td>12.8</td>
</tr>
</tbody>
</table>

Source: Own calculations.
5.3. Robustness checks

Positive shocks to aggregate demand obtained from the benchmark models increase all types of loans. Better economic outlook improves the number of investment projects which are considered as profitable in terms of expected net present value. This induces banks to loose lending policy. However, there is some heterogeneity in their reactions. In models containing loans on current account and for working capital, all terms and conditions become less stringent; standards behave likewise, but in this case we do not obtain a statistically significant reaction. In models with long-term loans, either on investment or for real property acquisition, only some T&Cs are loosened – in the case of loans for investment this is spread, whereas in the case of loans for real property acquisition – spread, non-interest rate cost and maximum maturity. Thus, it seems that bank policy with respect to WC&CA loans changes with the business cycle, whereas it does somewhat less so in the case of loans for investment. The policy with respect to RPA lending remains somewhere in between.

Positive shocks to demand for loans bring about diversified reactions of the investigated variables, depending on the type of credit used in estimates. On one hand, reactions obtained from models with RPA loans do not display any significant reactions of either investment or the interest rate. On the other hand, those from models using other types of loans show a fall in the interest rate. This is implausible and – as expected – casts doubts whether our models properly identify shocks to credit demand.

Responses to credit demand shocks obtained from the enlarged setting as in (6), show that that in the case of these to credit on current account and for working capital, the lending rate does not react at all for one to two quarters after the impulse and then tends to fall; they also increase investment, but the effect is delayed. Shocks to demand for investment loans increase lending rate by about 5 basis points for two quarters; they leave investment practically intact. Finally, shocks to demand for loans for real property acquisition, which are much larger than those to investment loans or WC&CA loans, induce a statistically significant increase in both WIBOR rate and the
lending rate by about 20 basis points 4 quarters after the impulse. As a result investment tends to fall, but the effect is not significant.

Shocks to the monetary policy rate obtained from the benchmark models tend to decrease investment and loans for real property acquisition. The reaction of loans for investment, although usually negative, is not significant. Credit on current account and for financing working capital temporarily increases, as in Giannone et al. (2019) and falls only after some 4 quarters after the impulse; this may once again support the hypothesis of a substitution between investment loans and credit on current account. Loans for sole proprietors display behaviour similar to that of WC&CA loans. Besides, interest rate shocks worsen capital position of banks and induce tightening of lending standards, terms and conditions. The reactions of standards for SMEs are larger than those for LEs.

Shocks to bank lending standards for SMEs (tightening) obtained from models with investment loans induce a statistically significant decline of investment and investment loans. Shocks to standards for LEs have a similar impact on investment, but the reaction of loans, although negative, is not significant. Loans for real property acquisition do not react to shocks to standards. Shocks to standards on short-term loans, induce negative reactions of both investment and loans on current account and for working capital, but they are not statistically significant.

All in all, besides shocks to demand for credit, other shocks identified in the benchmark models induce impulse response functions which are consistent with the economic theory or empirical findings in the literature.

Models employing POLONIA rate give smaller responses of investment and loans to shocks to capital, since POLONIA itself increases less to these shocks. Nonetheless, the responses are not qualitatively different comparing to the benchmark specification. None of the dummy variables has a visible impact on the results.
6. Summary and conclusions

In the paper, we show how shocks to bank capital, as reported in the Senior Loan Officer Opinion Survey, conducted by Narodowy Bank Polski, affect bank lending policy and activity of the real sector. We plug survey data into a suite of structural vector autoregression models and examine reactions of various types of loans to the corporate sector: for investment, for real property acquisition, loans on current account and for financing working capital. To show reactions of the supposedly riskiest firms, we also consider loans extended to sole proprietors, i.e. tiny business run by the owner, seemingly suffering the most from the agency problem and asymmetric information.

The estimates bring three major conclusions. Firstly, they show that shocks to capital position affect lending standards on long-term and short-term loans for both, large (LEs) and small and medium-sized enterprises (SMEs). They also have an impact on all considered T&Cs: average spread, spread on riskier loans, collateral, non-interest rate cost, maximum size and maturity of a loan. This means that shocks to capital lead banks to reduce credit supply. Importantly, banks tend to react rather through these T&Cs which are related to price, such as average spread and spread on riskier loans. This has implications for the monetary policy. As shown in Wróbel (2018), monetary policy shocks also affect lending standards, terms and conditions. Put it another way, monetary shocks and shocks to capital are transmitted through the same channels. Thus, there is a need for a good calibration of the two policies to avoid situations of a too tight/too loose policy mix. For example, contractionary monetary policy increases the price of credit and constraints credit availability to the new borrowers due to a fall in value of collateral. Tightening of macroprudential policy through increased capital ratio would result in the even higher spreads and lending cost, lower supply of loans and changes in the structure of supply towards lower risk.

This leads us to the second conclusion, namely, to the pattern of bank responses to shocks to capital. Our estimates show that following such innovations, more banks tend to tighten credit policy with respect to SMEs than to LEs. Thus, banks apparently intend to de-risk their credit portfolios. As a result, SMEs may face more problems
with access to external financing and are more vulnerable to macro-prudential policy than LEs. This also means that some sectors, such as services, which are more populated by SMEs, can be more affected by macroprudential tightening than other sectors.

Thirdly, we show that shocks to capital constrain lending, but to a diversified extent. Loans for real property acquisition and those extended to sole proprietors display the largest reactions. This is also an argument supporting our conclusion that banks de-risk their credit portfolios. Moreover, shocks to capital do have real effects – investment falls after a negative innovation to the capital position of banks. The effect is transitory, but not negligible.
References


Cohen B.H. (2013), How have banks adjusted to higher capital requirements? BIS Quarterly Review, September, Bank for International Settlements.


Strahan P. E. (1999), Borrower Risk and the Price and Nonprice Terms of Bank Loans, Staff Reports, 90, Federal Reserve Bank of New York.


Wolf Ch. K. (2019), SVAR (Mis)Identification and the Real Effects of Monetary Policy Shocks, mp_id_201907.pdf (princeton.edu)

Wróbel E. (2018), What is the impact of central bank on banks’ lending policy with respect to the corporate sector? Evidence from SLOOS for Poland, Bank and Credit, 49(6), 596-638.

Statistical Appendix

1. Figures

Figure A1. Selected non-bank sources of the enterprise sector financing

PLN billion

Source: Financial System in Poland, NBP, various editions

Figure A2. Allocation of short-term and long-term loans to LEs (LH panel) SMEs (RH panel), 2019, in % of total short-term or long-term loans

Source: Own calculations, GUS data
Figure A3. HP detrended: TCR*, accumulated responses on capital from SLOOS (LH axis) and investment (RH axis)

* To the end of 2013 Capital Adequacy Ratio
Source: Own estimates

Figure A4. Bank loans to firms/GDP, debt securities/GDP (LH) and TCR* (RH axis), in %

*To the end of 2013 Capital Adequacy Ratio
Source: NBP, PFSA, Eurostat

Figure A5. TCR* (LH) and accumulated data on capital position from SLOOS (RH axis)

Source: NBP

Figure A6. Capital position from SLOOS, change, q/q (1=100%)

Source: NBP
Figure A7. Standards on short- and long-term loans for LEs and SMEs (1=100%)

Source: NBP

Figure A8. Terms and conditions of lending to corporates (1=100%)

Source: Own calculations, NBP data.

Figure A9. Change in spread on loans to the corporate sector (RHS, in percentage points) and data on spreads from SLOOS (LHS, 1=100%)

Source: Own calculations, NBP data.

Figure A10. Change in spread on loans to sole proprietors (RHS, in percentage points) and data on spreads from SLOOS (LHS, 1=100%)

Source: Own calculations, NBP data.
Table A1. Descriptive statistics of the declared “climate” in various non-financial economic activities, 2003-2019 (June)

<table>
<thead>
<tr>
<th></th>
<th>manufacturing</th>
<th>construction</th>
<th>trade, repair</th>
<th>transport, storage</th>
<th>real estate</th>
<th>information, communication</th>
<th>accommodation</th>
<th>catering</th>
<th>administrative activities</th>
<th>professional, scientific activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.917677</td>
<td>-5.495960</td>
<td>-0.386364</td>
<td>0.631818</td>
<td>6.701515</td>
<td>20.04495</td>
<td>3.089394</td>
<td>0.030303</td>
<td>2.958586</td>
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<tr>
<td>Median</td>
<td>5.250000</td>
<td>-7.400000</td>
<td>1.300000</td>
<td>0.300000</td>
<td>7.550000</td>
<td>16.90000</td>
<td>4.200000</td>
<td>-0.600000</td>
<td>3.200000</td>
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</tr>
<tr>
<td>Skewness</td>
<td>0.050415</td>
<td>-0.092434</td>
<td>-0.941922</td>
<td>-0.122709</td>
<td>-1.202584</td>
<td>0.855417</td>
<td>-0.238747</td>
<td>-0.016111</td>
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<tr>
<td>Kurtosis</td>
<td>3.024193</td>
<td>3.017252</td>
<td>3.788092</td>
<td>2.610533</td>
<td>5.577701</td>
<td>2.694972</td>
<td>2.357103</td>
<td>2.156769</td>
<td>2.981108</td>
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</tr>
<tr>
<td>Jarque-Bera</td>
<td>0.088703</td>
<td>0.284408</td>
<td>34.40216</td>
<td>1.748291</td>
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<td>0.000000</td>
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<td>0.053008</td>
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<tr>
<td>Coeff. of variation</td>
<td>1.400562</td>
<td>2.985671</td>
<td>28.28672</td>
<td>12.06733</td>
<td>1.055201</td>
<td>0.503230</td>
<td>3.073436</td>
<td>2.000000</td>
<td>2.844257</td>
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</table>

Source: Own calculations

Table A2. Descriptive statistics of the declared “financial situation” in various non-financial economic activities, 2003-2019 (June)

<table>
<thead>
<tr>
<th></th>
<th>manufacturing</th>
<th>construction</th>
<th>trade, repair</th>
<th>transport, storage</th>
<th>real estate</th>
<th>information, communication</th>
<th>accommodation</th>
<th>catering</th>
<th>administrative activities</th>
<th>professional, scientific activities</th>
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<tr>
<td>Maximum</td>
<td>7.300000</td>
<td>19.30000</td>
<td>42.00000</td>
<td>11.50000</td>
<td>8.200000</td>
<td>41.10000</td>
<td>19.20000</td>
<td>4.800000</td>
<td>10.60000</td>
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<td>Skewness</td>
<td>-0.718457</td>
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<td>-0.034863</td>
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<td>-1.103014</td>
<td>-0.943207</td>
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<td>Kurtosis</td>
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<td>3.935097</td>
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<tr>
<td>Jarque-Bera</td>
<td>20.03586</td>
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<td>0.708246</td>
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<td>100.8687</td>
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<td>69.11925</td>
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<td>0.000000</td>
<td>0.001990</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
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</tr>
<tr>
<td>Coeff. of variation</td>
<td>1.020676</td>
<td>1.270206</td>
<td>0.655200</td>
<td>1.246620</td>
<td>1.264397</td>
<td>1.673917</td>
<td>2.694471</td>
<td>0.890814</td>
<td>1.315978</td>
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</table>

Source: Own calculations
Table A3. Correlation between data on spread from banks’ statistics and SLOOS in time $t$, $t-1$ and $t+1$

<table>
<thead>
<tr>
<th>Balanced sample: 2004Q3-2019Q3</th>
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<tbody>
<tr>
<td>$d(i_{t}^{corp} - i_{t}^{mm})$</td>
</tr>
<tr>
<td><strong>Spread,$i^{*}$</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Spread_riskier,$i^{sp}$</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>$d(i_{t}^{sp} - i_{t}^{mm})$</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Spread_riskier,$i^{sp}$</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Note: $d(i_{t}^{corp} - i_{t}^{mm})$ stands for a first difference of spread of the lending rate to the corporate sector over the money market rate (WIBOR 3M), $d(i_{t}^{sp} - i_{t}^{mm})$ for a first difference of spread of the lending rate to sole proprietors over the money market rate (WIBOR 3M); spread, and spread_riskier, stand for information of a change in the average spread and spread on the riskier loans from SLOOS; t-statistics in parentheses.

Source: Own calculations, NBP data.

Table A4. Data used in the estimates; the sample used for SVAR estimations covers the period 2003Q4-2019Q2.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Transformation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans to the corporate sector in the domestic currency (for investment, for real property acquisition, for WC&amp;CA)</td>
<td>The log of, multiplied by 100, s.a</td>
<td>NBP</td>
</tr>
<tr>
<td>Loans to sole proprietors</td>
<td>The log of, multiplied by 100, s.a</td>
<td></td>
</tr>
<tr>
<td>Investment, Poland, chain linked, 2010</td>
<td>The log of, multiplied by 100, s.a., corrected for working days</td>
<td>Eurostat</td>
</tr>
<tr>
<td>Investment, euro area, chain linked, 2010</td>
<td>The log of, multiplied by 100, s.a., corrected for working days</td>
<td>Eurostat</td>
</tr>
<tr>
<td>WIBOR 3M, percent per annum</td>
<td>Quarterly average of the 3-month daily rate</td>
<td>Reuters</td>
</tr>
<tr>
<td>EURIBOR 3M, percent per annum</td>
<td>Quarterly average of the 3-month daily rate</td>
<td>ECB (SDW)</td>
</tr>
<tr>
<td>POLONIA, percent per annum</td>
<td>Quarterly average of the daily overnight rate; missing observations for 2003.4-2004.4 supplemented with quarterly average of the daily WIBOR overnight rate</td>
<td>NBP, Reuters</td>
</tr>
</tbody>
</table>
### Table A3
Correlation between data on spread from banks’ statistics and SLOOS in time

<table>
<thead>
<tr>
<th>Variable</th>
<th>Transformation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans to the corporate sector, real terms</td>
<td>Quarterly average of monthly rate</td>
<td>NBP</td>
</tr>
<tr>
<td>Average interest rate on new and renegotiated business, per cent per annum</td>
<td>Quarterly average of monthly rate</td>
<td>NBP</td>
</tr>
<tr>
<td>Investment deflator, 2010 =100</td>
<td>The log of, multiplied by 100, s.a.</td>
<td>Eurostat</td>
</tr>
<tr>
<td>GDP deflator, 2010 = 100</td>
<td>The log of, multiplied by 100, s.a.</td>
<td>Eurostat</td>
</tr>
<tr>
<td>Lending standards (on long term and short-term credits to: (i) LEs, and (ii) SMEs)</td>
<td>Multiplied by -100</td>
<td>NBP, SLOOS</td>
</tr>
<tr>
<td>Lending terms and conditions: spread, spread for riskier borrowers, non-interest rate cost, maximum size, maximum maturity, required collateral</td>
<td>Multiplied by -100</td>
<td>NBP (SLOOS)</td>
</tr>
<tr>
<td>Capital position of banks</td>
<td>Multiplied by -100</td>
<td>NBP (SLOOS)</td>
</tr>
<tr>
<td>Loans to the corporate sector, real terms</td>
<td>Loans to the corporate sector-investment deflator</td>
<td>Own calculations</td>
</tr>
<tr>
<td>Loans to sole proprietors, real</td>
<td>Loans to sole proprietors - GDP deflator</td>
<td>Own calculations</td>
</tr>
</tbody>
</table>

Note: \( \Delta \) stands for a first difference of spread of the lending rate to the corporate sector over the money market rate (WIBOR 3M), \( \Delta' \) for a first difference of spread of the lending rate to sole proprietors over the money market rate (WIBOR 3M); spread and spread_riskiert stand for information of a change in the average spread and spread on the riskier loans from SLOOS; t-statistics in parentheses.

Source: Own calculations, NBP data.

### Table A4
Data used in the estimates; the sample used for SVAR estimations covers the period 2003Q4-2019Q2.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Transformation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans to the corporate sector, real terms</td>
<td>The log of, multiplied by 100, s.a.</td>
<td>NBP</td>
</tr>
<tr>
<td>Loans to sole proprietors, real</td>
<td>The log of, multiplied by 100, s.a., corrected for working days</td>
<td>Eurostat</td>
</tr>
<tr>
<td>WIBOR 3M, percent per annum</td>
<td>Quarterly average of the 3-month daily rate</td>
<td>Reuters</td>
</tr>
<tr>
<td>EURIBOR 3M, percent per annum</td>
<td>Quarterly average of the 3-month daily rate</td>
<td>ECB (SDW)</td>
</tr>
<tr>
<td>POLONIA, percent per annum</td>
<td>Quarterly average of the daily overnight rate; missing observations for 2003.4-2004.4 supplemented with quarterly average of the daily WIBOR overnight rate</td>
<td>NBP, Reuters</td>
</tr>
<tr>
<td>Interest rate on credit on current account (outstanding amounts), per cent per annum</td>
<td>Quarterly average of monthly rate</td>
<td>NBP</td>
</tr>
<tr>
<td>Average interest rate on new and renegotiated business, per cent per annum</td>
<td>Quarterly average of monthly rate</td>
<td>NBP</td>
</tr>
<tr>
<td>Investment deflator, 2010 =100</td>
<td>The log of, multiplied by 100, s.a.</td>
<td>Eurostat</td>
</tr>
<tr>
<td>GDP deflator, 2010 = 100</td>
<td>The log of, multiplied by 100, s.a.</td>
<td>Eurostat</td>
</tr>
<tr>
<td>Lending standards (on long term and short-term credits to: (i) LEs, and (ii) SMEs)</td>
<td>Multiplied by -100</td>
<td>NBP, SLOOS</td>
</tr>
<tr>
<td>Lending terms and conditions: spread, spread for riskier borrowers, non-interest rate cost, maximum size, maximum maturity, required collateral</td>
<td>Multiplied by -100</td>
<td>NBP (SLOOS)</td>
</tr>
<tr>
<td>Capital position of banks</td>
<td>Multiplied by -100</td>
<td>NBP (SLOOS)</td>
</tr>
<tr>
<td>Loans to the corporate sector, real terms</td>
<td>Loans to the corporate sector-investment deflator</td>
<td>Own calculations</td>
</tr>
<tr>
<td>Loans to sole proprietors, real</td>
<td>Loans to sole proprietors - GDP deflator</td>
<td>Own calculations</td>
</tr>
</tbody>
</table>